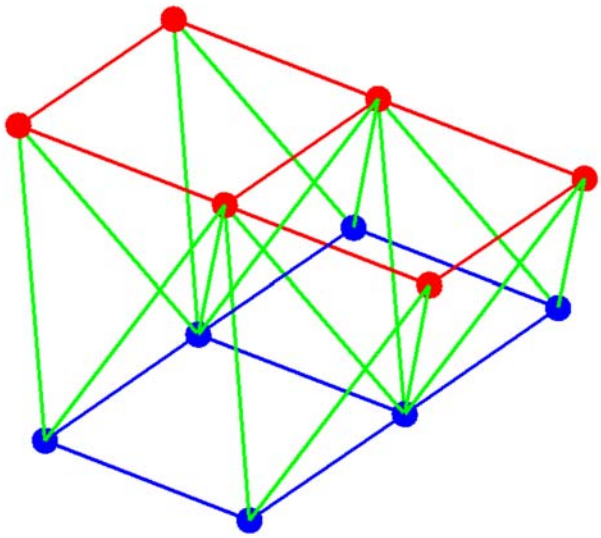
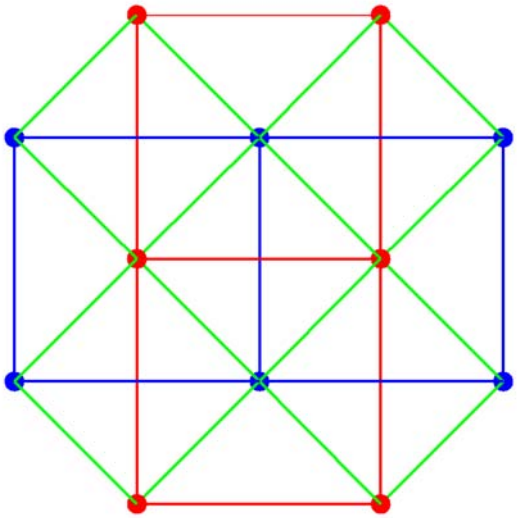
CIE 514 – Introduction to Advanced Mathematics and Mechanics
Assignment #3 – Static stability: mechanisms and prestress modes

A tetrahedral-octahedral truss consists of two identical square grids in two horizontal planes, with the joints of the top grid being vertically aligned with the centers of the squares in the bottom grid. Each joint of the bottom grid is connected to the nearest neighboring joints in the top grid. The simplest possible tetrahedral-octahedral truss, with two squares each in the bottom and top grids, is shown in the figure below.



A 3D view of a tetrahedral-octahedral truss



Top view of a tetrahedral-octahedral truss

These pictures were generated using a MATLAB script, `CreateTetraOctaTruss.m`, which is also posted on UBlearns. The goal in this assignment is to determine the static indeterminacy and the internal mechanisms of this truss.

1. Develop the deformation-displacement matrix B for a 3D truss member [done in part 1 of Assignment #1].
2. Modify `simpleFEA`, so that it assembles the deformation-displacement matrix B for the whole truss, rather than the stiffness matrix K [this is one of the rare instances for which the global B matrix has to be assembled].
3. Compute the rank of B, and hence the degree of static indeterminacy and number of mechanisms.
4. Find representations of the mechanisms, i.e. a basis for the null space of B.
5. Compute the rigid-body modes of the structure.
6. Deduce the internal mechanism(s) by orthogonally projecting elements of the null space of B on to the space of rigid body modes. (Review section 6 of Pellegrino and Calladine (1985), posted on UBlearns) [you can use the function `drawTetraOctaTruss` to animate this mechanism].
7. Find representations of the pre-stress modes of the truss, i.e., a basis for the null space of $B^\top$.